

**What is claimed is:**

1 1. A method for allocating user transmission rates in a communication system that is  
2 adapted to permit the users to transmit data simultaneously via shared frequency and  
3 spatial resources, the method comprising:

4 while maintaining the transmission rates of the users to at least a minimum user  
5 transmission rate to provide an expected minimum quality of communication for each of  
6 the users, incrementally adjusting the transmission rates of the users by iteratively  
7 changing the transmission rate of each user as a function of

8 a resulting vector of transmit powers ensuing from the increased  
9 transmission rate,

10 a degree of transmission-rate-allocation unfairness relative to the  
11 transmission rates of all the users, and

12 a power-based selection criteria.

1 2. The method of claim 1, wherein the degree of transmission-rate-allocation  
2 unfairness is a function of a ratio of a maximum user transmission rate to a minimum user  
3 transmission rate.

1 3. The method of claim 1, further including using the resulting vector and the degree  
2 of transmission-rate-allocation unfairness to identify a user for the corresponding  
3 iteration and, therefrom, increasing its transmission rates in a next iteration.

1     4.     The method of claim 1, further including using the resulting vector and the degree  
2     of transmission-rate-allocation unfairness to identify a user from the set of all users, that  
3     optimizes the selection criteria for the corresponding iteration and, therefrom, increasing  
4     its transmission rates in a next iteration.

1     5.     The method of claim 1, wherein the system is an OFDM (orthogonal-frequency-  
2     division-multiplex) communication system and further including transmitting the data  
3     from the users using OFDM communication.

1     6.     The method of claim 1, wherein the system is a CDMA (code-division-multiple-  
2     access) communication system and further including transmitting the data from the users  
3     using CDMA communication.

1     7.     The method of claim 1, further including setting the transmission rates of the  
2     users to the minimum user transmission rate before incrementally adjusting the  
3     transmission rates of the users.

1     8.     The method of claim 1, wherein iteratively changing the transmission rate of each  
2     user includes iteratively changing the transmission rate by a constant.

1     9.     The method of claim 1, wherein the power-based selection criteria is selected  
2     from the set of: minimization of average transmit power; minimization of maximum  
3     transmit power; and minimization of total received power.

1 10. A method for allocating transmission rates to multiple users in a communication  
2 system that is adapted to permit the users to transmit data simultaneously via shared  
3 frequency and spatial resources, the method comprising:

4 (a) setting the transmission rates of the users to at least a minimum user  
5 transmission rate to provide an expected minimum quality of communication for each of  
6 the users and then incrementally adjusting the transmission rates of the multiple users by  
7 iteratively increasing the transmission rates per the following steps:

8 (b) for each user, increasing its transmission rate without changing the  
9 transmission rate of the other users, thereby providing a set of transmission rates that  
10 include a maximum user transmission rate and a minimum user transmission rate and,  
11 therefrom, determining

12 a resulting vector of transmit powers ensuing from the increased  
13 transmission rate, and

14 a degree of transmission-rate-allocation unfairness as a function of a ratio  
15 of a maximum user transmission rate to a minimum user transmission rate;

16 (c) from the resulting vector and the degree of transmission-rate-allocation  
17 unfairness, determining whether an increased one of the transmission rates for a  
18 corresponding one of the users satisfies a multi-user based selection criteria and, in  
19 response, increasing its transmission rate.

1 11. The method of claim 10, wherein the multi-user based selection criteria includes a  
2 power-based selection criteria, and further including, after step (c), repeating steps (b)

3 and (c) until an iteration in which none of the transmission rates satisfies the power-based  
4 selection criteria and satisfies the degree of transmission-rate-allocation unfairness.

1 12. The method of claim 10, wherein the system is an OFDM (orthogonal-frequency-  
2 division-multiplex) communication system and further including transmitting the data  
3 from the users using OFDM communication.

1 13. The method of claim 12, wherein the multi-user based selection criteria includes a  
2 power-based selection criteria, and further including, after step (c), repeating steps (b)  
3 and (c) until an iteration in which none of the transmission rates satisfies the power-based  
4 selection criteria and satisfies the degree of transmission-rate-allocation unfairness.

1 14. The method of claim 10, wherein the system is an OFDM (orthogonal-frequency-  
2 division-multiplex) communication system permitting the users to transmit the data on  
3 multiple frequencies and further including transmitting the data from the users using  
4 OFDM communication.

1 15. The method of claim 10, wherein the system is a CDMA (code-division-multiple-  
2 access) communication system and further including transmitting the data from the users  
3 using CDMA communication.

1 16. The method of claim 15, wherein the multi-user based selection criteria includes a  
2 power-based selection criteria, and further including, after step (c), repeating steps (b)

3 and (c) until an iteration in which none of the transmission rates satisfies the power-based  
4 selection criteria and satisfies the degree of transmission-rate-allocation unfairness.

1 17. The method of claim 10, further including, after step (c), repeating steps (b) and  
2 (c) until an iteration in which none of the transmission rates satisfies the degree of  
3 transmission-rate-allocation unfairness.

1 18. The method of claim 10, further including, after step (c), repeating steps (b) and  
2 (c) until an iteration in which none of the transmission rates satisfies the multi-user based  
3 selection criteria.

1 19. The method of claim 10, further including, after step (c), repeating steps (b) and  
2 (c) until an iteration in which none of the transmission rates satisfies the multi-user based  
3 selection criteria and, thereafter, attempting to optimize system operation.

1 20. A communication system adapted to allocate transmission rates to multiple users  
2 and to permit the users to transmit data simultaneously via shared frequency and spatial  
3 resources, the system comprising:

4 means for maintaining the transmission rates of the users to at least a minimum  
5 user transmission rate to provide an expected minimum quality of communication for  
6 each of the users; and

7 means, operative while maintaining the transmission rates of the users to at least a  
8 minimum user transmission rate, for incrementally adjusting the transmission rates of the  
9 users by iteratively changing the transmission rate of each user as a function of  
10 a resulting vector of transmit powers ensuing from the increased  
11 transmission rate,  
12 a degree of transmission-rate-allocation unfairness relative to the  
13 transmission rates of all the users, and  
14 a power-based selection criteria.

1 21. A communication system adapted to allocate transmission rates to multiple users  
2 and to permit the users to transmit data simultaneously via shared frequency and spatial  
3 resources, the system comprising:

4 means for setting the transmission rates of the users to at least a minimum user  
5 transmission rate to provide an expected minimum quality of communication for each of  
6 the users; and

7 means for incrementally adjusting the transmission rates of the multiple users by  
8 iteratively increasing the transmission rates as follows:

9 for each user, increasing its transmission rate without changing the  
10 transmission rate of the other users, thereby providing a set of transmission rates that  
11 include a maximum user transmission rate and a minimum user transmission rate and,  
12 therefrom, determining

13 a resulting vector of transmit powers ensuing from the increased  
14 transmission rate, and

15                   a degree of transmission-rate-allocation unfairness as a function of a ratio  
16                   of a maximum user transmission rate to a minimum user transmission rate; and  
17                   from the resulting vector and the degree of transmission-rate-allocation  
18                   unfairness, determining whether an increased one of the transmission rates for a  
19                   corresponding one of the users satisfies a multi-user based selection criteria and, in  
20                   response, increasing its transmission rate.

1    22.    The system of claim 21, wherein the system is an OFDM (orthogonal-frequency-  
2           division-multiplex) communication system permitting the users to transmit the data on  
3           multiple frequencies and further including transmitting the data from the users using  
4           OFDM communication.

1    23.    The method of claim 21, wherein the system is a CDMA (code-division-multiple-  
2           access) communication system and further including transmitting the data from the users  
3           using CDMA communication.

1    24.    The method of claim 21, wherein the system is a CDMA (code-division-multiple-  
2           access) cellular communication system and wherein the rate allocation is provided to  
3           multiple users communicating with a common base station for the cellular  
4           communication system, and further including transmitting the data from the users to  
5           common base station using CDMA communication.

1    25.    For use in a communication system adapted to allocate transmission rates to  
2    multiple users and to permit the users to transmit data simultaneously via shared  
3    frequency and spatial resources, a data terminal comprising:  
4            a clock-based circuit that maintains a data transmission rate of the data terminal as  
5    a function of a minimum user transmission rate defined to provide an expected minimum  
6    quality of communication for each of the users; and  
7            a data transmission rate adjustment circuit that incrementally adjusts the  
8    transmission rate of the data terminal as a function of  
9            a resulting vector of system-level transmit powers ensuing from the  
10    incremental adjustment of the transmission rate,  
11            a degree of transmission-rate-allocation unfairness relative to the  
12    transmission rates of all the users, and  
13            a system-level power-based selection criteria.